RESEARCH HIGHLIGHTS

July 2002 Technical Series 02-102

TRANSFORMING YOUR PRACTICE: INTEGRATED DESIGN CHARRETTES FOR SUSTAINABLE BUILDINGS

Introduction

A design charrette held in Toronto in November 2001, *Transforming Your Practice: Integrated Design Charrettes for Sustainable Buildings*, used the integrated design process (IDP) to push building performance towards more sustainable practices. IDP can be used to advance designs in a number of areas in addition to green building designs.

The keys to successfully using the process include:

- early introduction of all team members to the process and having them responsible for establishing performance goals at a building's concept stage
- ensuring teams are multi-disciplinary and include a design facilitator and energy simulator
- having team members share knowledge and test ideas together, thereby developing greater respect and understanding for each other's perspectives
- having teams conduct all aspects of design in a methodical manner.

Four partners joined with Canada Mortgage and Housing Corporation in sponsoring the Toronto charrette: Enbridge Consumers Gas; City of Toronto's Better Buildings Partnership; Natural Resources Canada's Office of Energy Efficiency; and the Canadian Energy Efficiency Alliance. Their goals were to:

- establish a forum where a multi-disciplinary group of design professionals work together on a sustainable design project
- gain insights into sustainable building practices
- learn how to advance building performance, from design concept to operation issues, by building on each other's unique perspectives and expertise.

A key element to the success of this charrette was the use of a real development site, the Radio City project on old CBC lands located in midtown Toronto. The developer and the developer's architect, mechanical engineer and structural engineer provided project information for the charrette, and each of the six design teams received a set of plans and data related to the proposed development. This provided the teams with practical design problems, a sense of tangibility and context in the marketplace.

The project partners selected seasoned experts with experience in IDP to act as facilitators and simulators to the charrette's design teams. Resource people were selected to provide specific areas of expertise to complement the composition of the design teams and enable the process to become more specific and less theoretical. For example, they provided access to information on costing, financial implications and building envelope alternative energy systems. Energy simulators used energy assessment software, so that the teams could readily assess how their design choices would influence energy use.

A total of 72 people attended the charrette, with 47 participating on the design teams, 18 being resource people to all six teams and the remaining 7 floating among the teams as observers.

Design challenges

Three of the teams explored multi-residential building (MURB) design issues, and three explored office design issues pertaining to a commercial-residential mixed-use project. The MURB project for the charrette was defined as a 25-storey, 169-suite condominium tower to be marketed to young professionals. The office project for the charrette was described as a 30-storey rental office tower, with parking below grade and a mechanical penthouse on the roof.

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Each group was assigned one of the following three sets of constraints and performance challenges:

- Design Teams "A" were constrained in orientation, geometry, size and site, essentially using the building as designed. The performance goal was to improve the building's energy efficiency by a minimum of 25 per cent over the Model National Energy Code for Buildings (MNECB).
- Design Teams "B" were constrained by the geometry and site, with changes permitted to the developed scheme, orientation and materials. The performance goal was to achieve at least a 50 per cent improvement in energy efficiency over the MNECB.
- Design Teams "C" were constrained by site only. The performance goal was to achieve at least a 75 per cent improvement in energy efficiency over the MNECB.

At the beginning of the charrette, team members received a kit containing direction on the charrette process, along with instructional and reference material.

Results

MURB Team A

In addition to the specified constraints (maintain orientation, geometry, size and site), the team adopted the following constraints:

- up to 1 per cent incremental cost (i.e. $190,000) for features to improve energy efficiency, indoor air quality and sustainability
- one-third of the building is rental and two-thirds are condominiums
- suites are individually metered for electricity and natural gas.

They also adopted, as their design goals, improving indoor air quality, minimizing parking and achieving market differentiation for the building, for example, through green and energy efficiency labels.

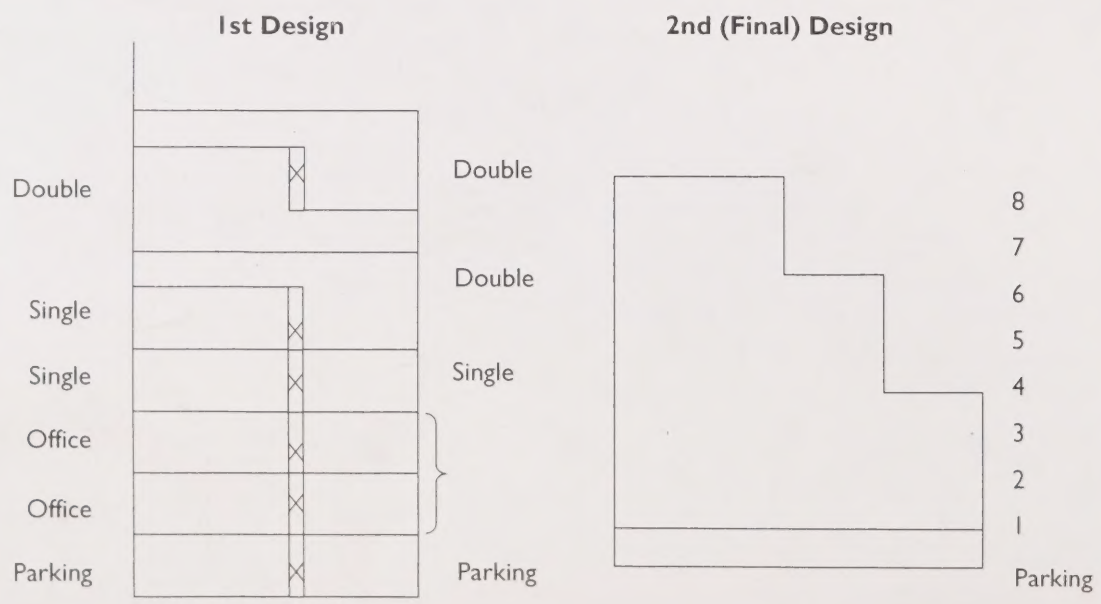
MURB Team A greatly exceeded its given target of at least 25 per cent improvement in energy efficiency. According to the energy simulations, it achieved 48 per cent through a combination of measures. The key ones included in-suite HRVs, a combined water loop heat pump and condensing boiler, and upgraded walls.

MURB Team B

This team decided that the project building, as drawn, was actually 20 per cent less energy efficient than the MNECB. They therefore considered their target as being 70 per cent improvement, not 50 per cent as stipulated. The design goals they set for themselves included making transportation to and from the building more sustainable; improving the livability of the building, e.g. better indoor air quality; improving aesthetics; making the building function as a neighbourhood/community contributor; capturing 100 per cent on-site rainwater; and reducing energy demand in the building by using natural renewable energy systems and other measures.

The team considered building envelope and mechanical measures. They were able to achieve 71 per cent in energy savings over the baseline, which gave them close to 53 per cent improvement over MNECB. Heat recovery, a water source heat pump, gas-fired heating efficiency and automated heat set point relaxation accounted for the greatest savings.

Figure 1. MURB team C design changes



MURB Team C

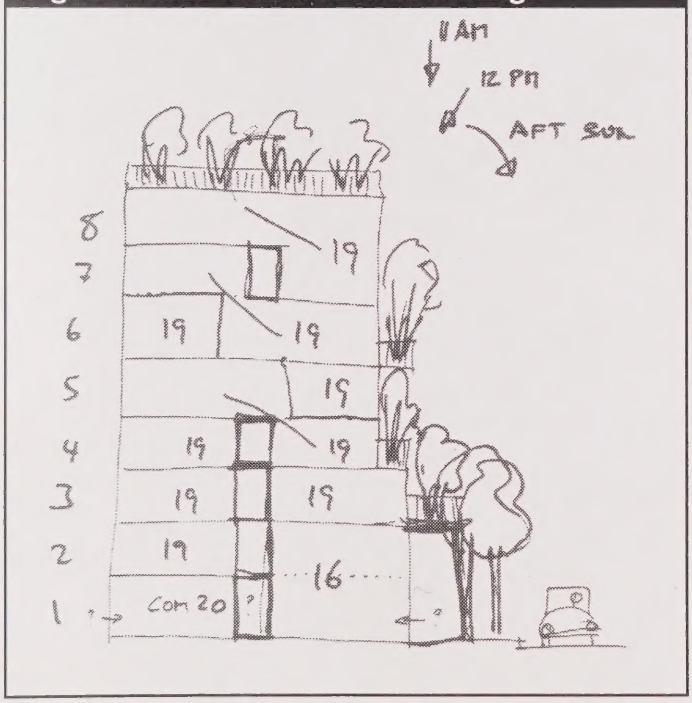
This team, constrained by site only, considered three building options:

- townhomes and a tower (i.e. the existing scheme)
- stacked and staggered townhomes and a lower tower
- stacked townhomes covering the full lot, with eight levels designed on the diagonal so that each unit spans the full building width and has two floor levels.

The last option was chosen as the preferred design (figure 1).

This design allows each unit to have a view of the street, cross-flow ventilation, reduced corridor space and a lower height which maintains a strong street relationship not possible with a higher tower. Other aspects of the design include angled balconies, which permitted passive solar gain, and commercial facilities on the lower floor, including a car rental agency. This last stipulation allowed the design team to reduce the parking area to one level.

Figure 2. Side view sketch of a design



MURB Team C met its design challenge, which was 75 per cent improvement over MNECB. Their measures included increased wall and window insulation, increased building air sealing, heat recovery (including from grey water), solar water heating, hydronic heat delivery, slab thermal storage, high-efficiency appliances and greater use of daylighting in common areas.

Office Team A

This team pursued two design options, one being a "spec" scenario and the other "purpose built". Both options exceeded the team's performance goal of 25 per cent improvement in energy efficiency over MNECB. The team also chose as its design goals good indoor air quality and reducing greenhouse gas/pollutant emissions.

The spec scenario achieved 43 per cent improvement using the following measures: increased wall insulation; lighting density of 8.8W/m^2; low-E coated windows; variable speed fan and pumps; condensing boiler; proximity sensor faucets; underfloor supply air; and waste heat from chiller for humidification. The team estimated an overall cost savings of $1.05 per square foot.

The purpose-built scenario achieved 53 per cent improvement using the same measures as in the spec scenario plus an overhang/light shelf, a green roof, tenant commitment to low-energy office equipment and a heat pump water heater added to SHW storage units.

Office Team B

This team was constrained by geometry and site, but could make additions to the scheme and change orientation and materials. They estimated energy consumption based on three types of tenants: high-tech companies (40 per cent of office space); government agencies (40 per cent); and miscellaneous companies (20 per cent).

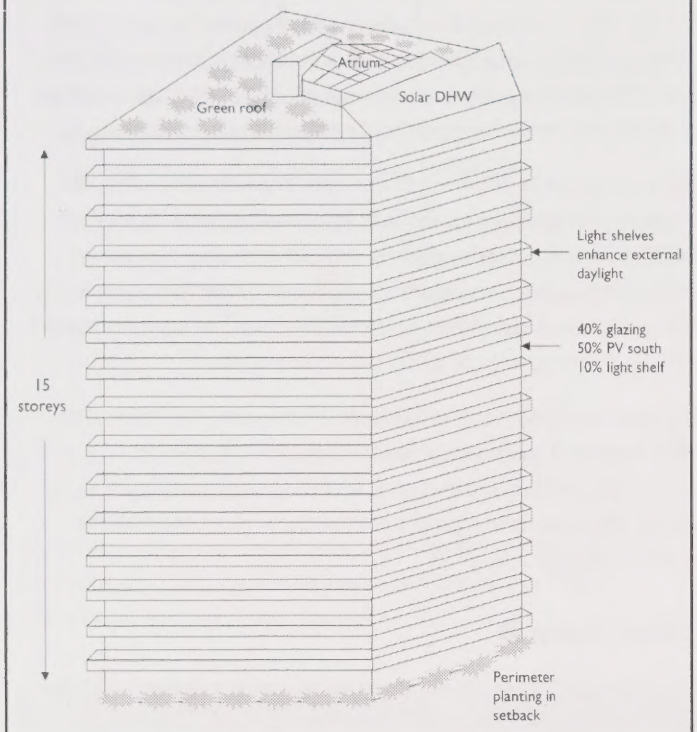
The team exceeded its target of 50 per cent improvement, achieving a total energy saving of almost 80 per cent. A central heat pump, a co-generation system and central plant mechanical upgrades were the key measures, followed by improvements or changes to wall sections, windows, roof, lighting and HVAC system. Mechanical upgrades included a condensing boiler, a high-efficiency chiller and a modulating cooling tower.

Office Team C

With site being the only constraining factor, this team considered the shape and height of the building, heat loss improvements, designing the space to improve productivity, single tenant/owner, high level of community integration (e.g. child care, public transportation), design considerations pertaining to the building exterior, construction materials, office systems, appliances, general and summer water use, indoor air quality, noise reduction and an alternative energy supply system.

The team achieved its target of 75 per cent improvement through a combination of several measures. The key ones were modification of the VAV system to a distributed ground source heat pump system, energy-efficient lighting and office equipment, higher temperature-differential heating coils, lower static pressure ventilation and a central atrium.

Figure 3. Side view rendering of building design



Conclusions

The charrette demonstrated how design professionals can use IDP and the advantage of using energy simulation software and various resource experts. Design teams were able to deal with complex sets of issues very quickly and reach their performance goals with relatively few measures. The combined involvement of developer, architects, engineers, energy simulators, property managers and costing experts gave the charrette considerable depth.

Most participants found the charrette met or exceeded their expectations. The developer expressed much satisfaction with the charrette, commenting that it provided workable solutions for the Radio City project, as well as innovative solutions for other projects he had planned for the immediate future. He noted that the three sets of constraints and performance goals proved to be a useful approach, as developers face different combinations of design restrictions.

The charrette was instructive not only in proving the value of IDP but also in how to structure such events in the future.

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Research Report: *Transforming your Practice: Integrated Design Charrettes for Sustainable Buildings*, 2002

Research Consultants: IndEco Strategic Consulting Inc.,

Research Partners: Enbridge Consumers Gas; City of Toronto's Better Buildings Partnership; Natural Resources Canada's Office of Energy Efficiency; and the Canadian Energy Efficiency Alliance

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Under Part IX of the *National Housing Act*, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

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